# Department of Physics – University of Strathclyde

The Physics degrees offered by the University of Strathclyde are accredited by the Institute of Physics. In order to graduate, a student must possess Physics skills to be able to:

- Tackle problems in Physics and formulate appropriate solutions
- Use mathematics to describe the physical world
- Plan, execute and report the results of an experiment or investigation
- Compare results critically with theoretical predictions

The degrees enhance transferable skills such as

- Problem-solving, including trying different approaches to tackle open ended problems
- Investigative Skills, finding information by using available literature and by searching databases and the Internet
- Communications skills, using technical language to communicate complex information effectively and concisely by means of written documents, presentations or discussion.
- Analytical skills, distilling a problem to its basic elements
- IT skills, preparing documents, performing information searches, numerical calculations, manipulating and presenting data
- Personal skills such as the ability to work independently, to use initiative, to meet deadlines and to interact constructively with other people

Strathclyde Integrated Masters programmes incorporate extended project work as a substantial part of the final two years. Projects may be experimental, observational, computational or theoretical depending on the topic. The objectives of such project work will include most of the following:

- investigation of a physics-based or physics-related problem
- planning, management and operation of an investigation to test a hypothesis
- development of information retrieval skills
- carrying out a health and safety assessment
- establishment of co-operative working practices with colleagues
- design, assembly and testing of equipment or software
- generation and informed analysis of data and a critical assessment of experimental (or other) uncertainties
- formulation of appropriate conclusions and a critical comparison with relevant theory
- production of a final written report
- presentation and defence of the results of the project

All our degrees cover the set of key concepts - Core of Physics – listed here with the years in which these concepts are taught to our students. Students from other institutions will be able to enter in year two, three, four or five depending on their familiarity with the following elements of the Core of Physics.

## Material to have been covered for direct entry to year 2

**Classical mechanics –** Newton's laws and linear conservation laws, Newtonian gravitation to the level of Kepler's laws.

**Background to quantum mechanics –** Black body radiation, Photoelectric effect, Wave-particle duality.

**Atomic, nuclear and particle physics –** Nuclear masses and binding energies, Radioactive decay, fission and fusion.

**Oscillations and Waves –** Waves on strings, sound waves and electromagnetic waves, Doppler effect.

**Optics** - Dispersion by prisms, Interference and diffraction at single and two apertures.

**Electromagnetism –** Electrostatics and magnetostatics.

**Mathematics –** Trigonometric and hyperbolic functions, complex numbers, vector algebra scalar and cross products, matrices to level of Gaussian elimination, integration by parts and substitution.

## Material to have been covered for direct entry to year 3

**Classical mechanics and Relativity –** Rotational conservation laws, Lorentz transformations and the energy-momentum relationship.

**Quantum mechanics –** In depth Black body radiation, Photoelectric effect, Wave-particle duality, Heisenberg's Uncertainty Principle, Schrödinger wave equation to include**,** Wave function and its interpretation.

**Condensed Matter Physics –** Mechanical properties of matter to include elasticity and thermal expansion, Inter-atomic forces and bonding, Phonons and heat capacity, Crystal structure and Bragg scattering.

**Oscillations and Waves –** Free, damped, forced and coupled oscillations to include resonance and normal modes, Waves in linear media to the level of group velocity.

**Electromagnetism –** Gauss, Faraday, Ampère, Lenz and Lorentz laws to the level of their vector expression, DC and AC circuit analysis to the level of complex impedance, transients and resonance.

**Optics –** Geometrical optics to the level of simple optical systems Interference and diffraction at multiple apertures, Dispersion by diffraction gratings, Optical cavities and lasers.

**Thermodynamics and Statistical Physics –** Zeroth, first and second laws of thermodynamics**,** Changes of state, Temperature scales, work, internal energy and heat capacity, Entropy, free energies and the Carnot Cycle, Kinetic theory of gases and the gas laws to the level of Van der Waals equation, Maxwell-Boltzmann distribution.

**Mathematics –** Series expansions, limits and convergence, Calculus to the level of multiple integrals, solution of linear ordinary and partial differential equations, Vectors to the level of div, grad and curl; divergence theorem and Stokes' theorem, Matrices to the level of eigenvalues and eigenvectors, Probability distributions, Fourier series.

## Material to have been covered for direct entry to year 4

**Quantum mechanics –** Standard solutions and quantum numbers to the level of the hydrogen atom, Tunneling, First order time independent perturbation theory.

**Atomic, nuclear and particle physics –** structure and spectra of simple atoms, Pauli exclusion principle, fermions and bosons and elementary particles, Fundamental forces and the Standard Model.

**Condensed Matter Physics –** Electron theory of solids to the level of simple band structure, Semiconductors and doping, Magnetic properties of matter - Year 3.

**Electromagnetism –** Maxwell's equations and plane electromagnetic wave solution; Poynting vector, Polarisation of waves and behaviour at plane interfaces, Electromagnetic spectrum.

**Statistical mechanics –** Statistical basis of entropy, Maxwell-Boltzmann distribution, Bose-Einstein and Fermi-Dirac distributions, Density of states and partition function.

**Mathematics –** Complex analysis, Cauchy-Riemann equations, Complex integration, Cauchy's integral formula, Taylor and Laurent series, Residue integration method. Integral transforms, Complex, Sine, Cosine, Fourier Transform; Special Functions –Legendre Polynomials, Bessel Functions; Sturm-Liouville problem: eigenfunctions, eigenvalues, orthogonality.